

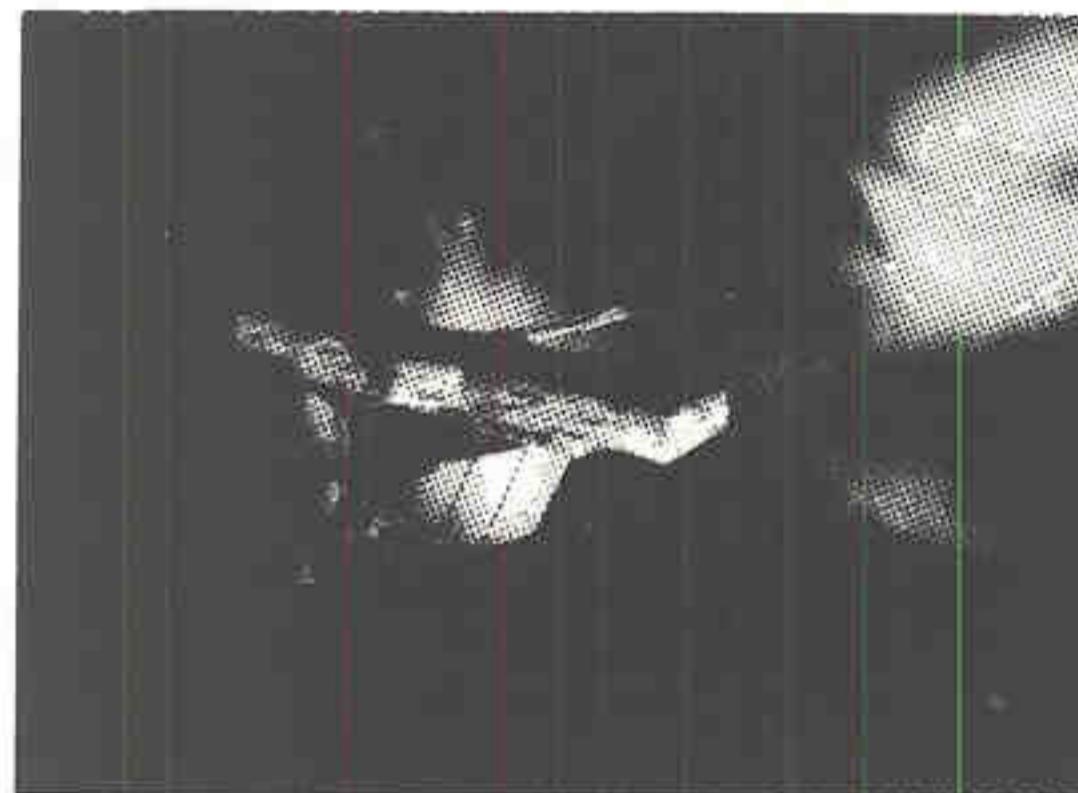
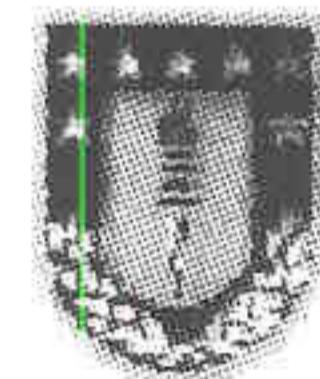
The Grid Giant Star Survey for the SIM Astrometric Grid



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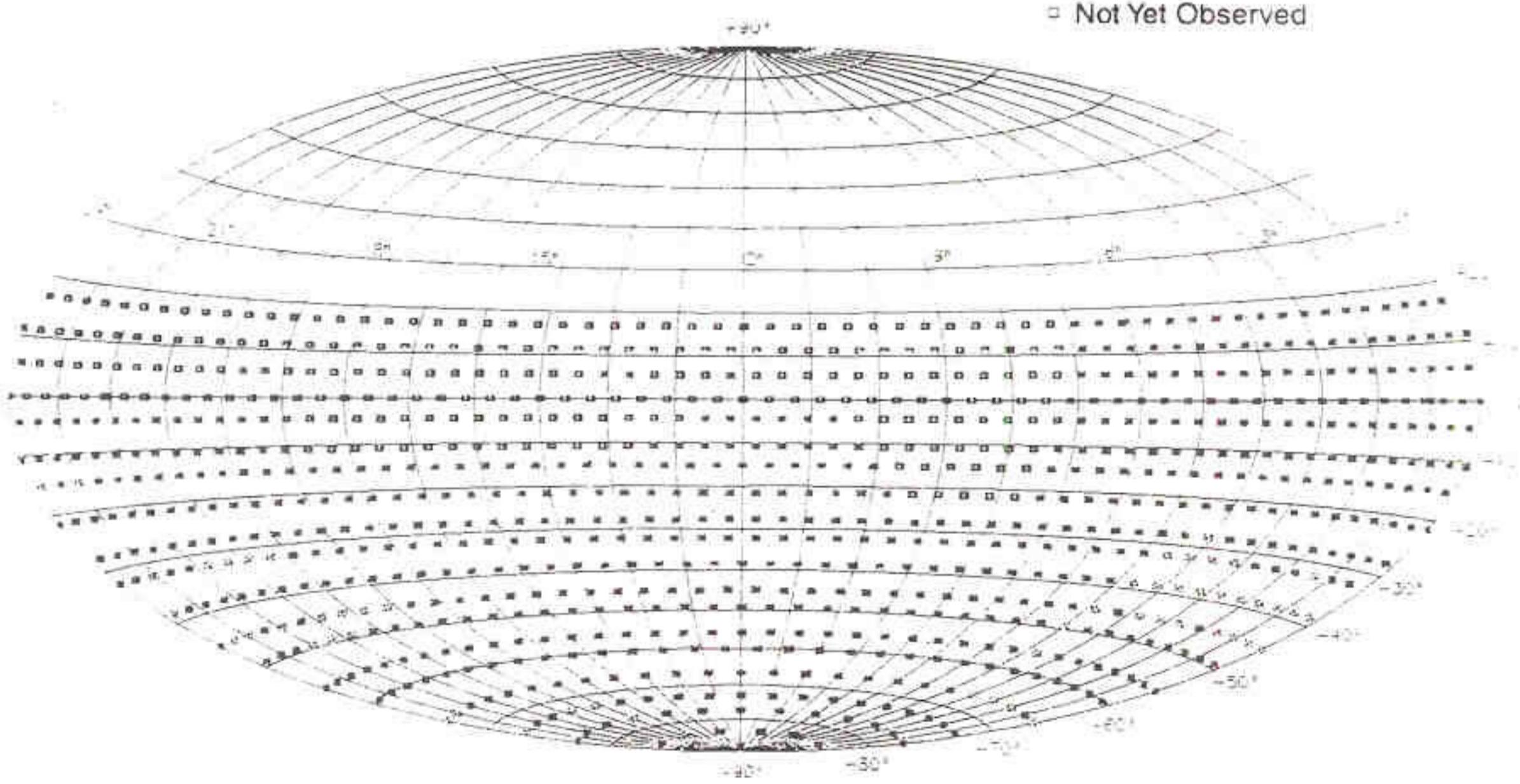
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Space Interferometry Mission
Astrometric Grid Giant Star Survey - South

(As of 1 Dec 1999)

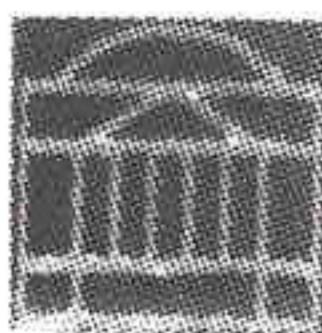
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- Spectra Taken
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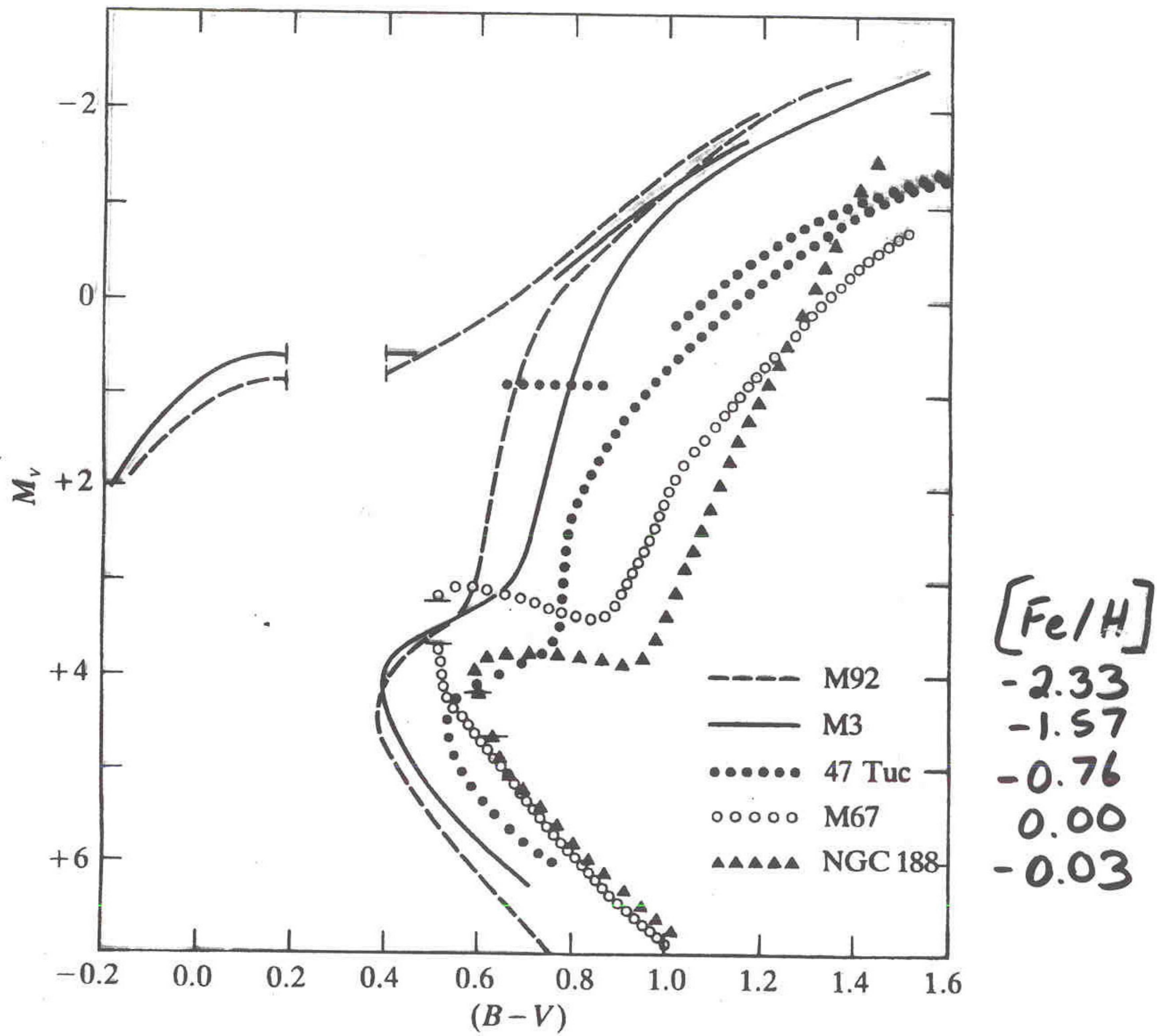


WHY USE SUB-SOLAR METALLICITY GIANTS FOR THE GRID?

- Common in all stellar populations
- Common along all lines of sight
- Bright, $0 > M_V > -2.5$,
 - So for $V \lesssim 12$ can reach to >5 kpc
- Magnitude of astrometric jitter decreases linearly with distance
 - e.g., at same V, $(d_{\text{KIII}} / d_{\text{GV}}) = 5 - 50$
 - Note: with same SIM overhead for $V < 12$, best to pick $V \sim 12$ to get distance
- With $V < 12$ limit, can find numerous *halo* and *Intermediate Pop II giants*
 - Extreme age, low [Fe/H] increases giant brightness and distance attainable
 - Older giant stars less likely to have planetary systems
 - metal-poor stars are less likely to have provided rocky core seeds for Jovian planets (Stevenson 1985; Cameron 1988. Note: stars with known planetary systems anomalously metal-rich compared to stars of similar age; Gonzalez 1999).
 - do not expect planets < 1 AU, more distant Jupiters cause undetectable reflex

● MONITORING ISSUES





POTENTIAL CONCERNS WITH GIANTS:

- **Starspotting and Flaring:**

Metal-poor K3 III at 6 kpc subtends 25 μ arcsecs, large spots would affect photocenter

- But G dwarf subtends similar angle on sky

- Rotationally induced chromospheric activity very low for $B-V > 0.9$ (late G early K)
(Simon & Drake 1989; Gray 1989)

- Activity more of a problem for less evolved G and K subgiants, which we can identify by colors and avoid

- **Binarity:**

- No evidence Pop II binarity fraction is larger than Pop I, and may be less (Ryan 1992).

- With followup monitoring we will remove stars with $\geq 5 \mu$ arcsecs variations (GGSS Phase III)

- **Brown Dwarfs:**

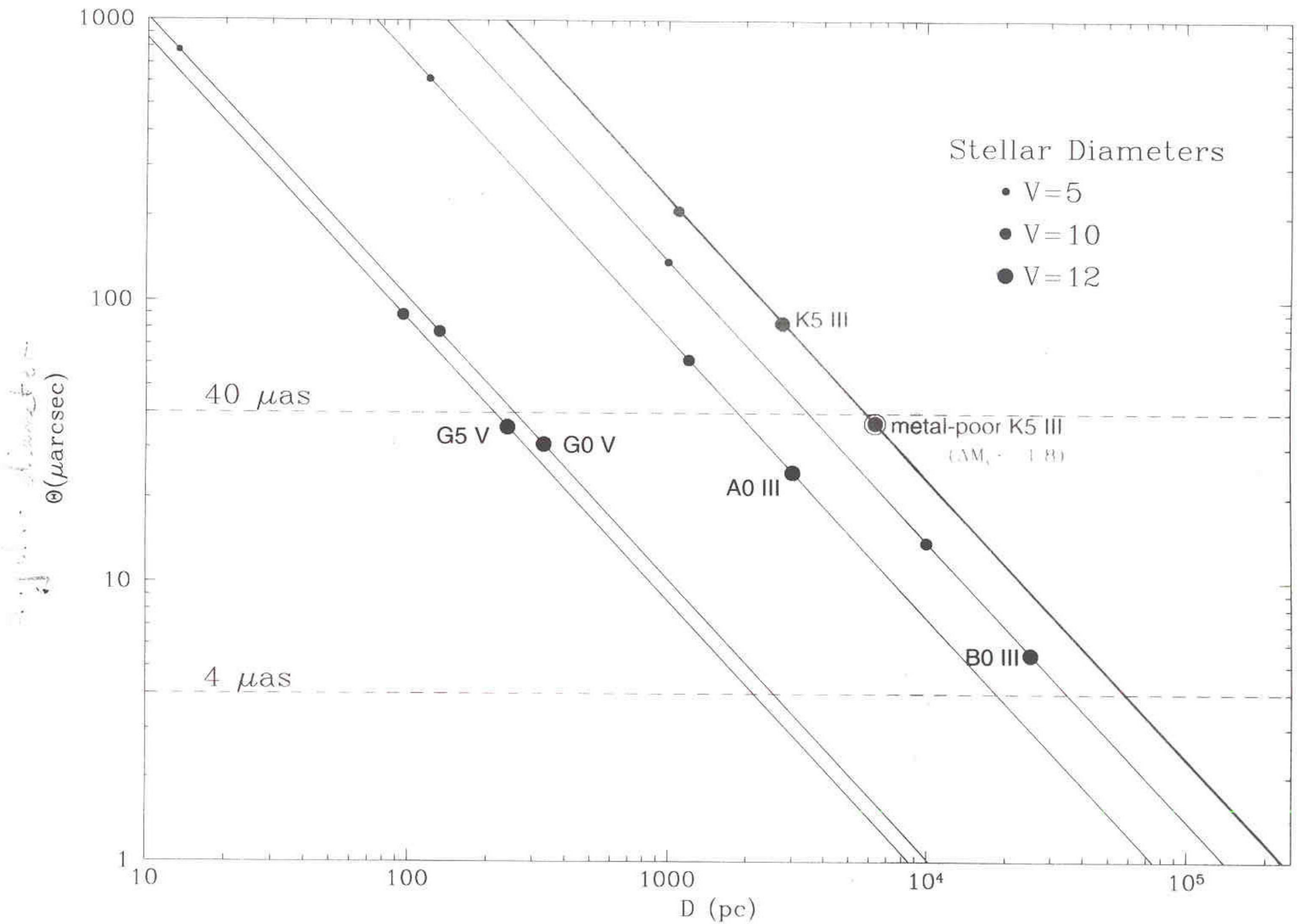
Could cause detectable reflex motion

- Problem for any grid star (THOUGH LESS SO FOR DISTANT ONES)

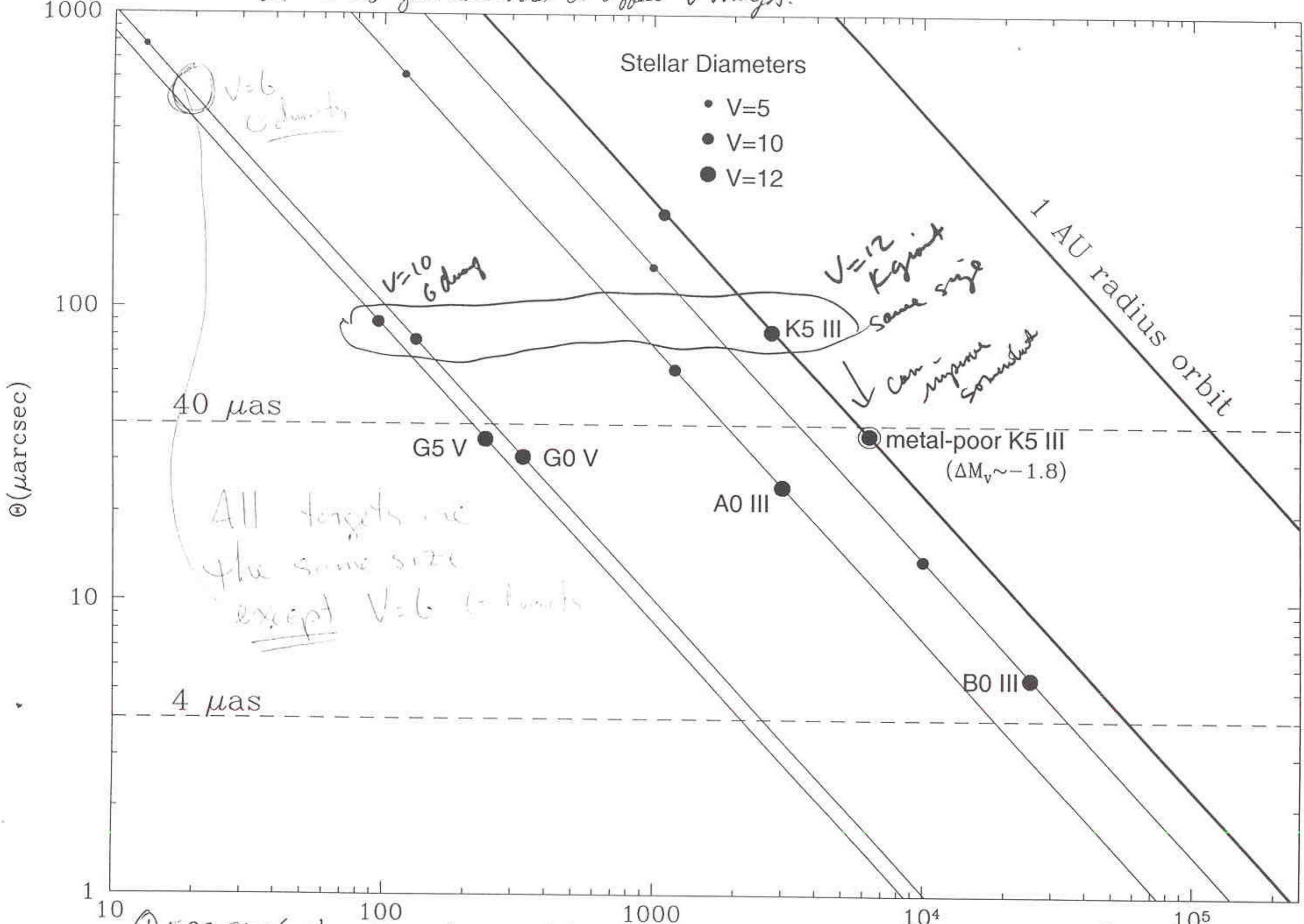
- Rare

- No evidence Pop II binarity fraction is larger than Pop I, and may be less (Ryan 1992)
- With followup monitoring we will remove stars with $\geq 5 \mu$ arcsecs variations (GGSS Phase III)





- we show grid candidates at offset V mags.

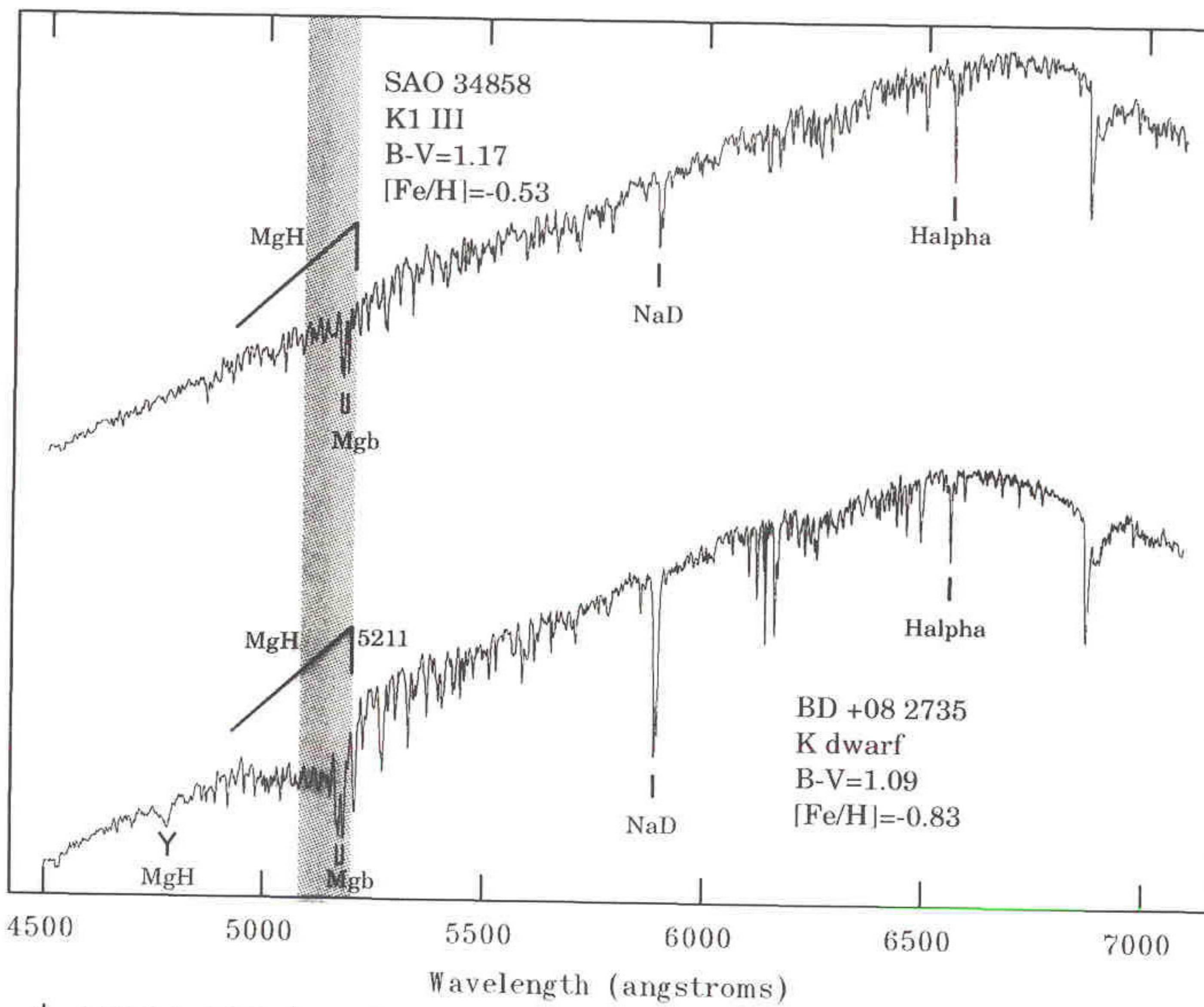


- ① FOR SAME V , G DWARFS + metal poor K giants same angular size
- ② Blue giants best however (HB)
- ③ for bright stars, $V \approx 5$, candidates generally $> 10 \times$ bigger

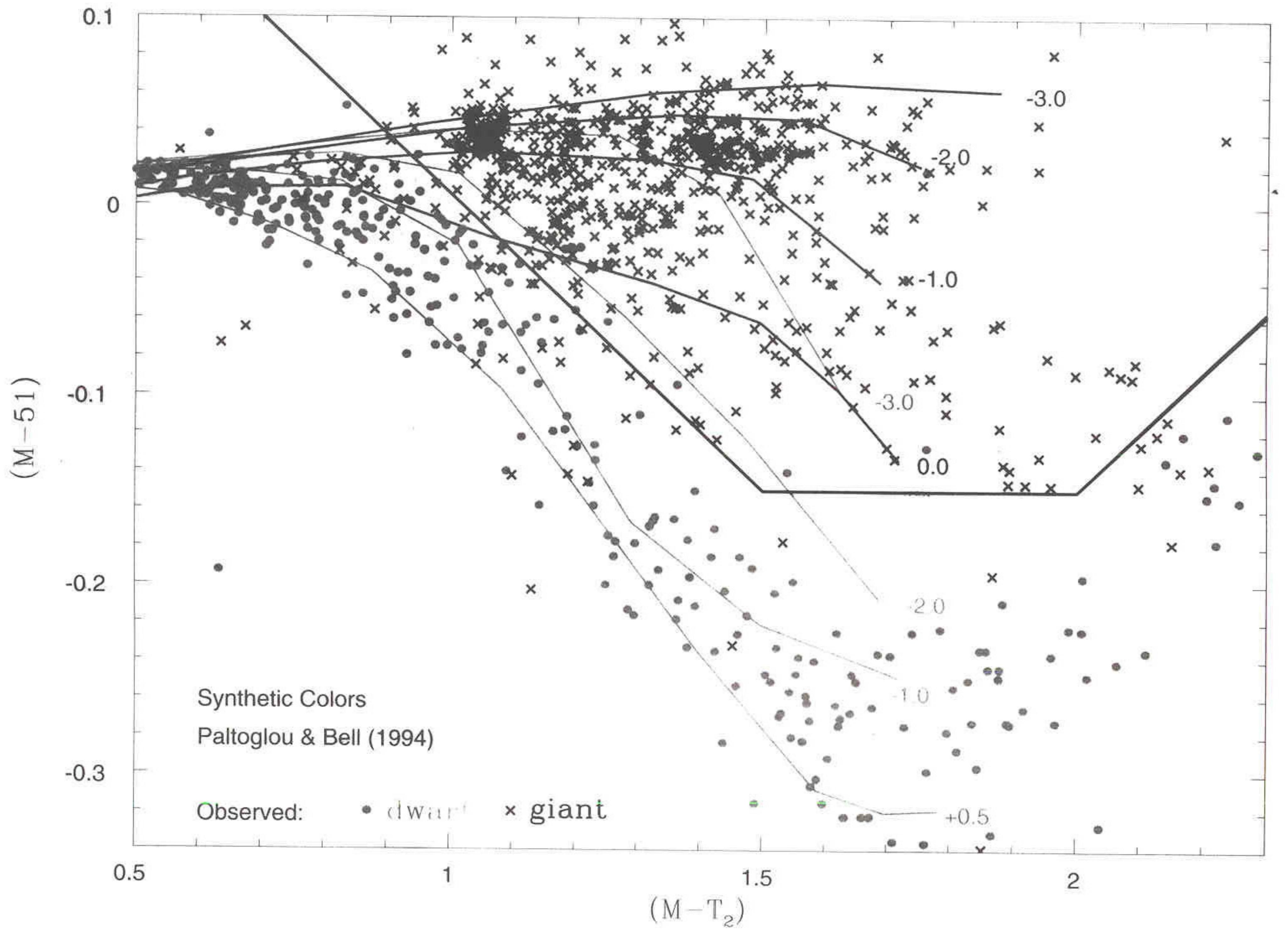
BASIS OF GRID GIANT STAR SURVEY (GSS)
DDO 51 SENSITIVITY TO GRAVITY, ABUNDANCES

DDO 51

passband



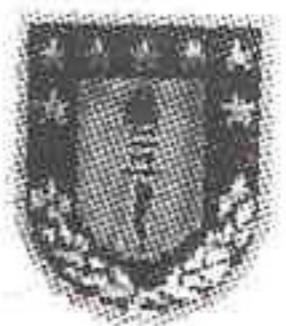
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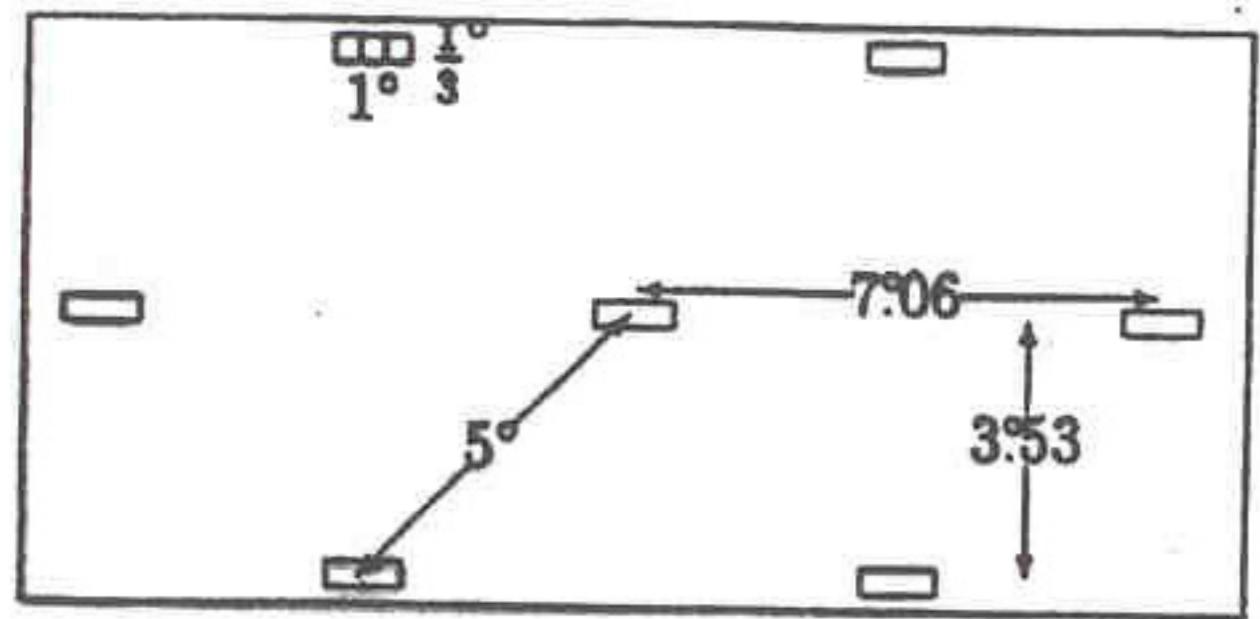


THREE PHASE GGSS STRATEGY

PHASE I: PHOTOMETRIC SURVEY

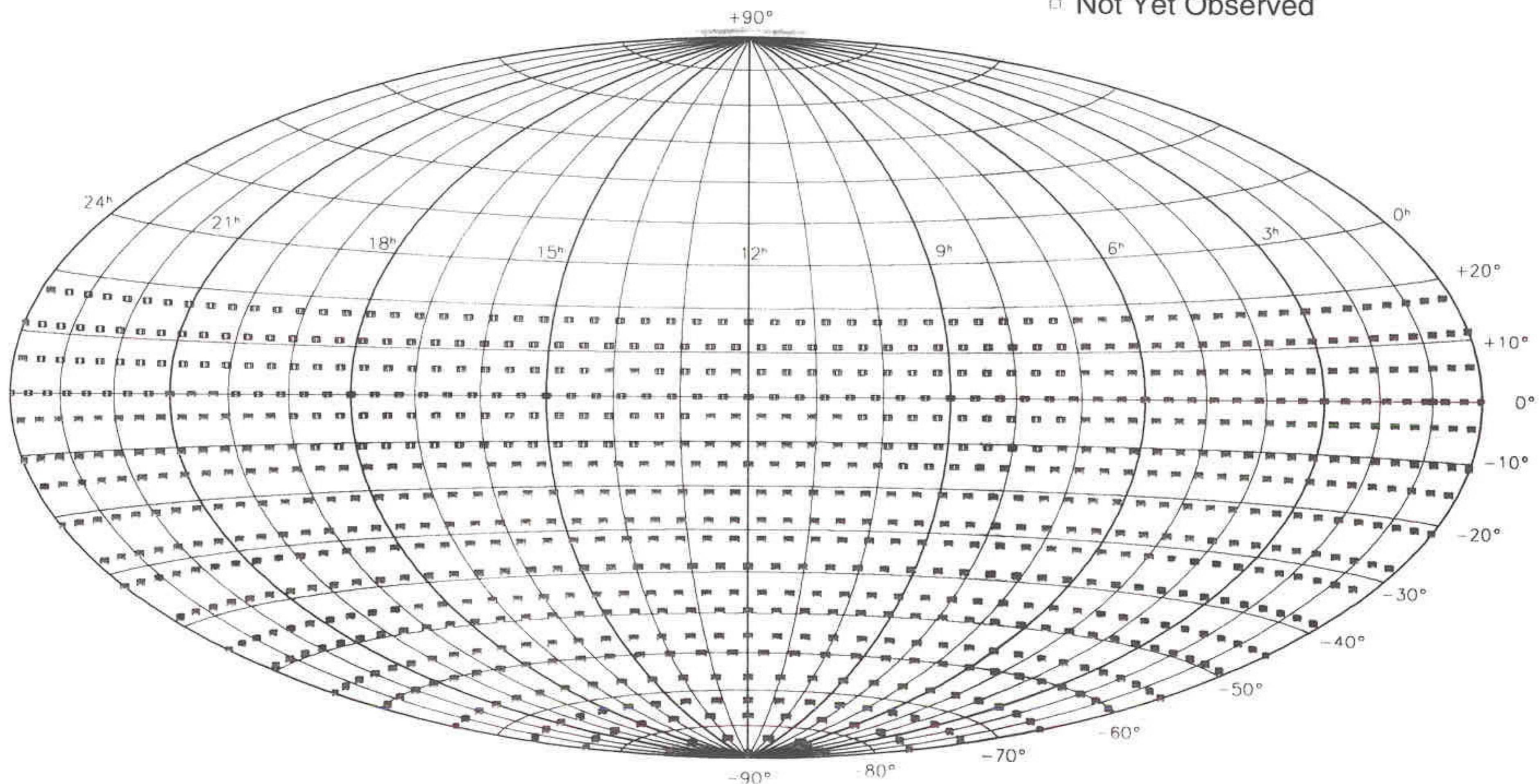
- SIM requires 10 - 15 stars per 15° diameter field of regard, or $0.05 - 0.1 \text{ stars deg}^{-2}$
- Our strategy to achieve this:
 - Placement of observed field "bricks" on sky
 - ◆ One $1^{\circ}0 \times 0^{\circ}33$ brick per $24 \text{ deg}^2 \rightarrow 0.33 \text{ deg}^2$ total giant candidates to $V \sim 12$
 - ◆ Select best giants (late K) with $M-T_2 > 1.3 \rightarrow 0.15 \text{ deg}^2$ to $V \sim 12$
 $\sim 20/\text{brick}$
 - ◆ Choose most metal-poor giants from 2 color diagram $\rightarrow 0.02-0.04 \text{ deg}^2$ to $V \sim 12$
 $10/\text{brick}$
 $1-2/\text{brick}$
 - (Note: latter criterion can be relaxed as needed to provide larger number of slightly less metal-poor candidates)
- Phase I nearly complete
- Northern GGSS survey proposed





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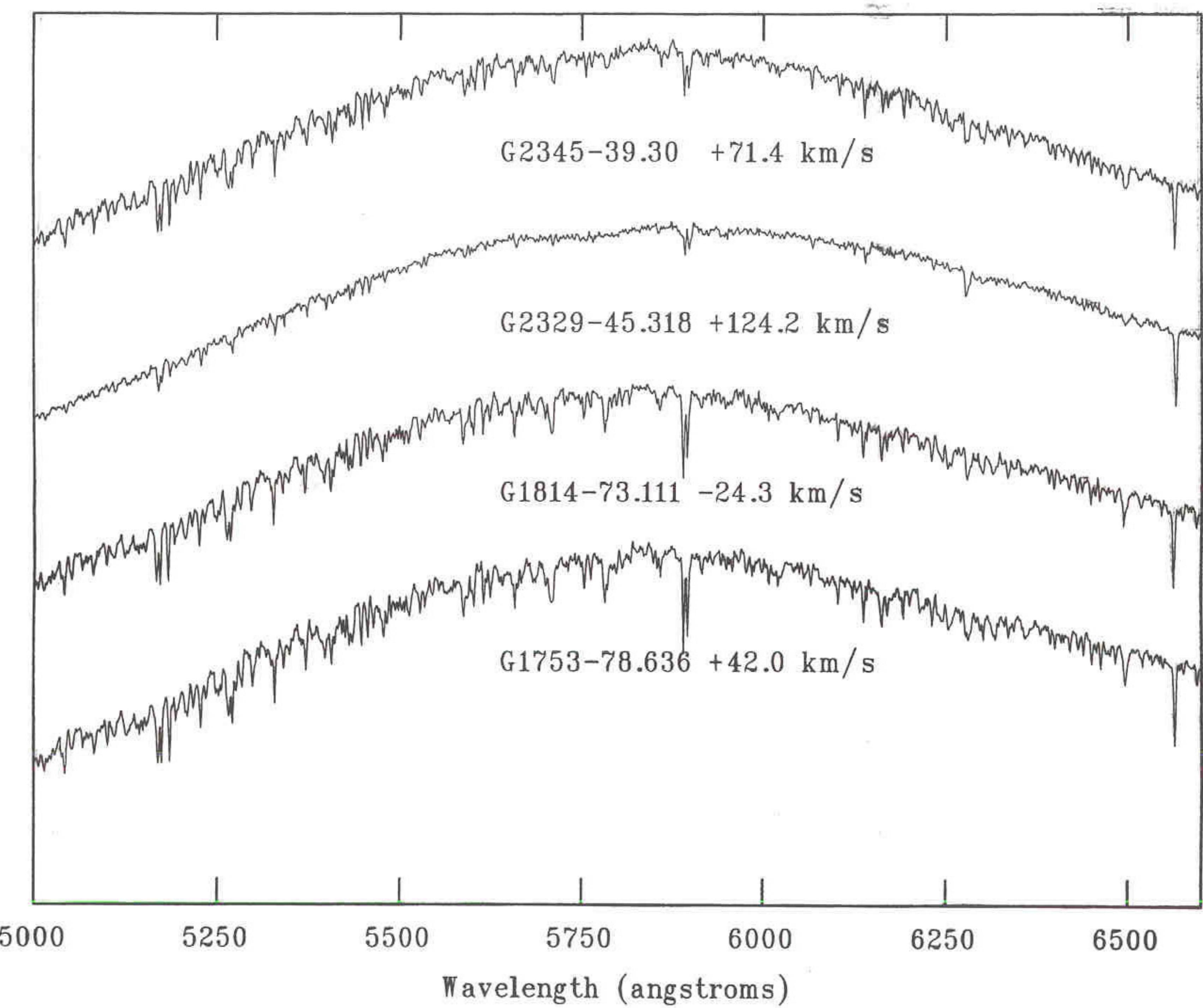
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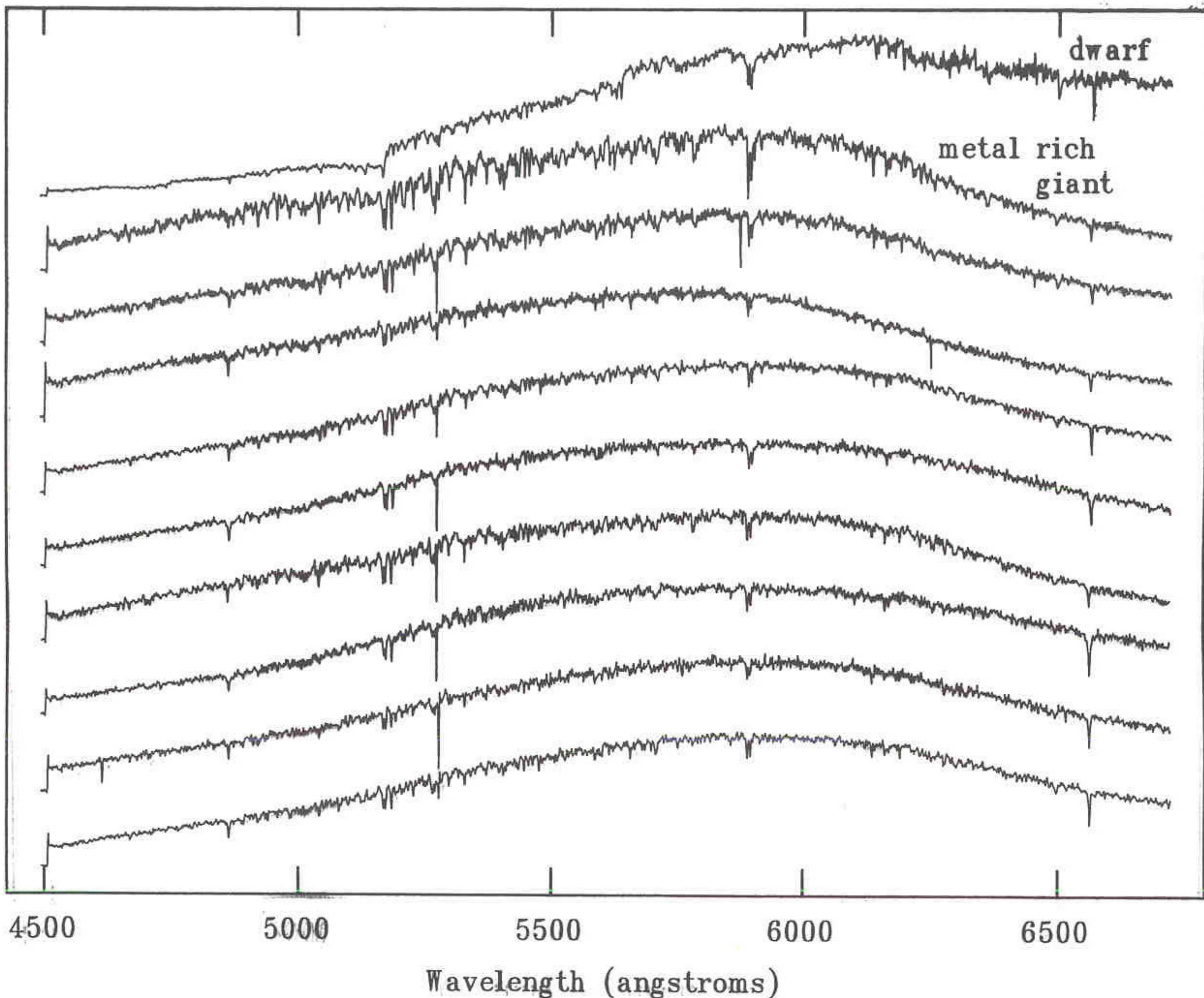
PHASE II: LOW RESOLUTION SPECTROSCOPIC FOLLOW UP

- Spectroscopic observations of candidates chosen to meet Phase I selection criteria
- Obtain moderate resolution (2 \AA resolution) spectra
 - Use MODSPEC on Swope 1-m (~6 stars/hour)
 - Sufficient to check classification and derive rough radial velocities ($\sigma \sim 10 \text{ km/s}$)
- Phase II is just underway.
 - Spectra show we are finding metal-poor giants (halo and Intermediate Population II) with near 100% accuracy



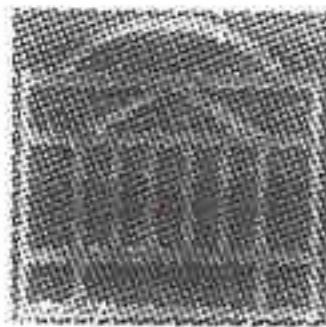


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PHASE III: CANDIDATE MONITORING (GEISLER, SMITH ET AL.)

- Photometric variability monitoring
(Swope 1-m, McDonald 0.8-m, Fan Mtn. 1-m)
 - Repeat (5 epochs) photometric observations of targets to remove obvious (> 0.02 mag) variables
- High resolution (50 m/s accuracy) radial velocity monitoring
(McDonald 2.1-m, ESO 1.5-m)
 - Remove almost all binaries/planetary companions with $\gtrsim 5 \mu\text{arcsecs}$ variations over 2 - 3 years.



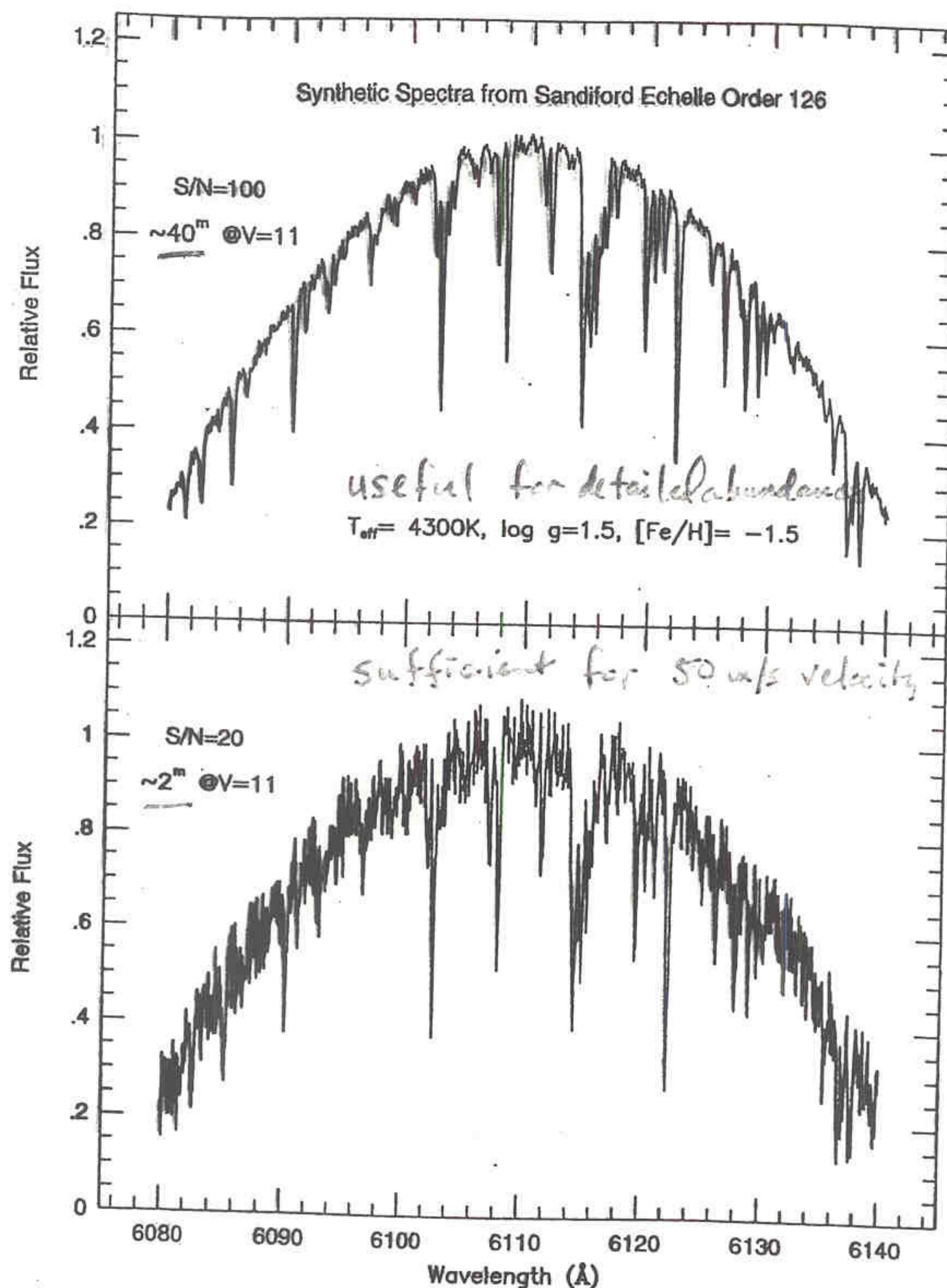
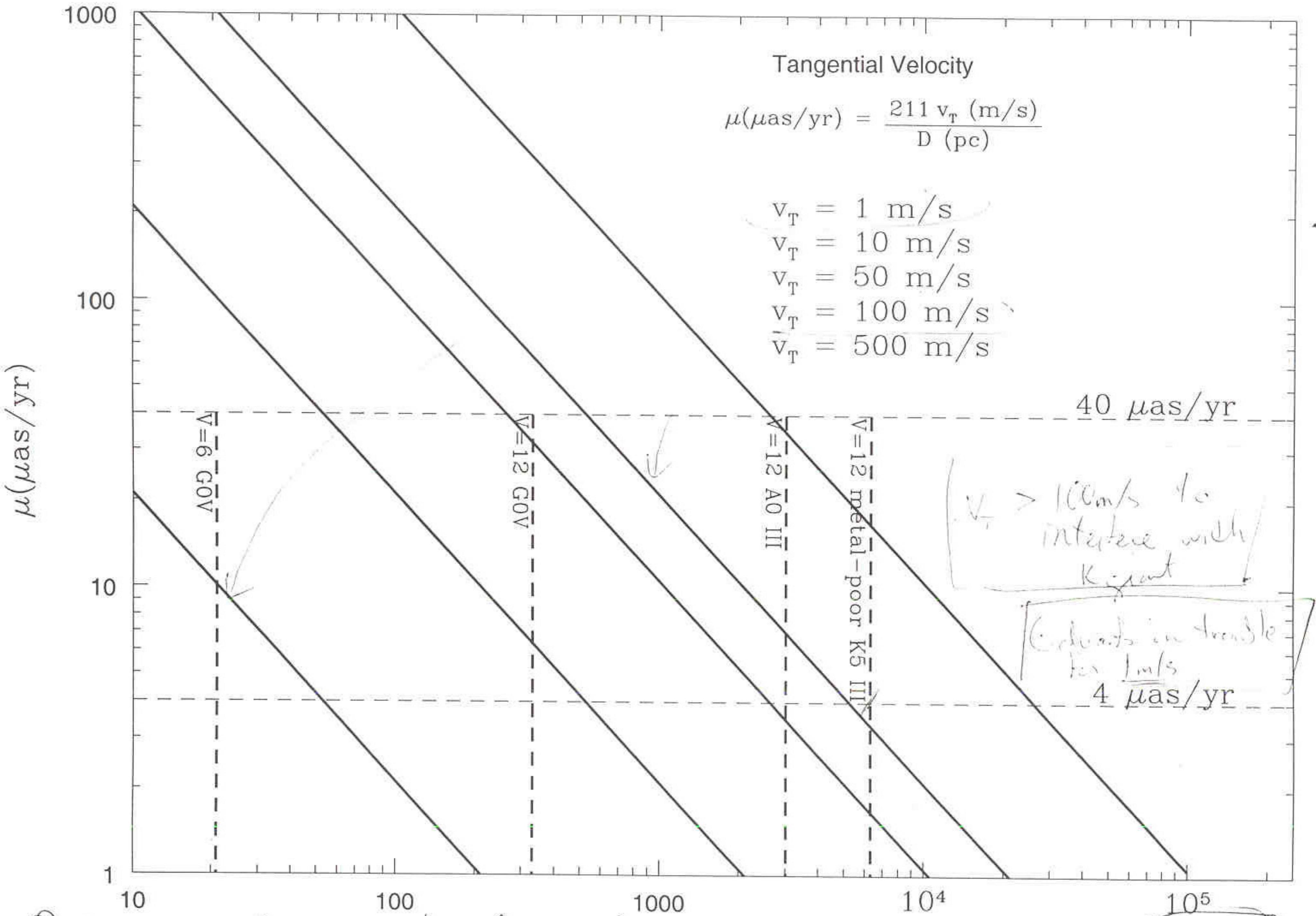


Figure 1: Simulated spectra of a metal-poor K-giant as observed with the McDonald 2.1m reflector plus cassegrain echelle spectrometer. This is order 126 and illustrates the quality of data obtained on a $V=11$ star for integration times of about 40 minutes (top panel) and 2 minutes (bottom panel). The higher-S/N spectrum is the quality required for a detailed abundance analysis, while the lower-S/N one is what is needed for RV accuracies of about 50 m s^{-1} .

$V=11$ ~ 12 stars/hour McDonald 2.1-m
 $V=12$ ~ 6 stars/hour McDonald 2.1-m
 80 nights/yr $\rightarrow \gtrsim 3000$ measures/year
 conservatively

equivalent transverse velocity for given radial velocity for candidates at different distances



- ① Note A0III, KIII @ $V=12$, don't need to monitor $D(\text{pc})$ to better than $50 \sim 100 \text{ m/s}$ (only this)
- ② $V=12$ G dwarf has to worry at 5 m/s level

